# MSR6 BE Solution

draft-lx-msr6-rgb-segment-03 & draft-xl-msr6-source-segment-02

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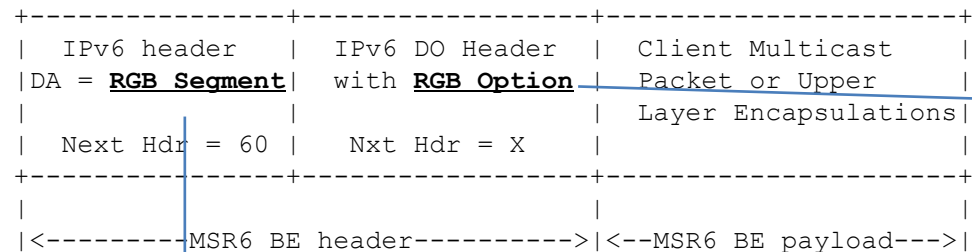
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MSR6 BE

- Root node indicates the target leaf nodes in the packet.
- Replication nodes replicate packets according to the leaf node information in the incoming packet.
- The packets are transferred as IPv6 unicast along the shortest path. Transit Nodes are MSR6 un-aware.
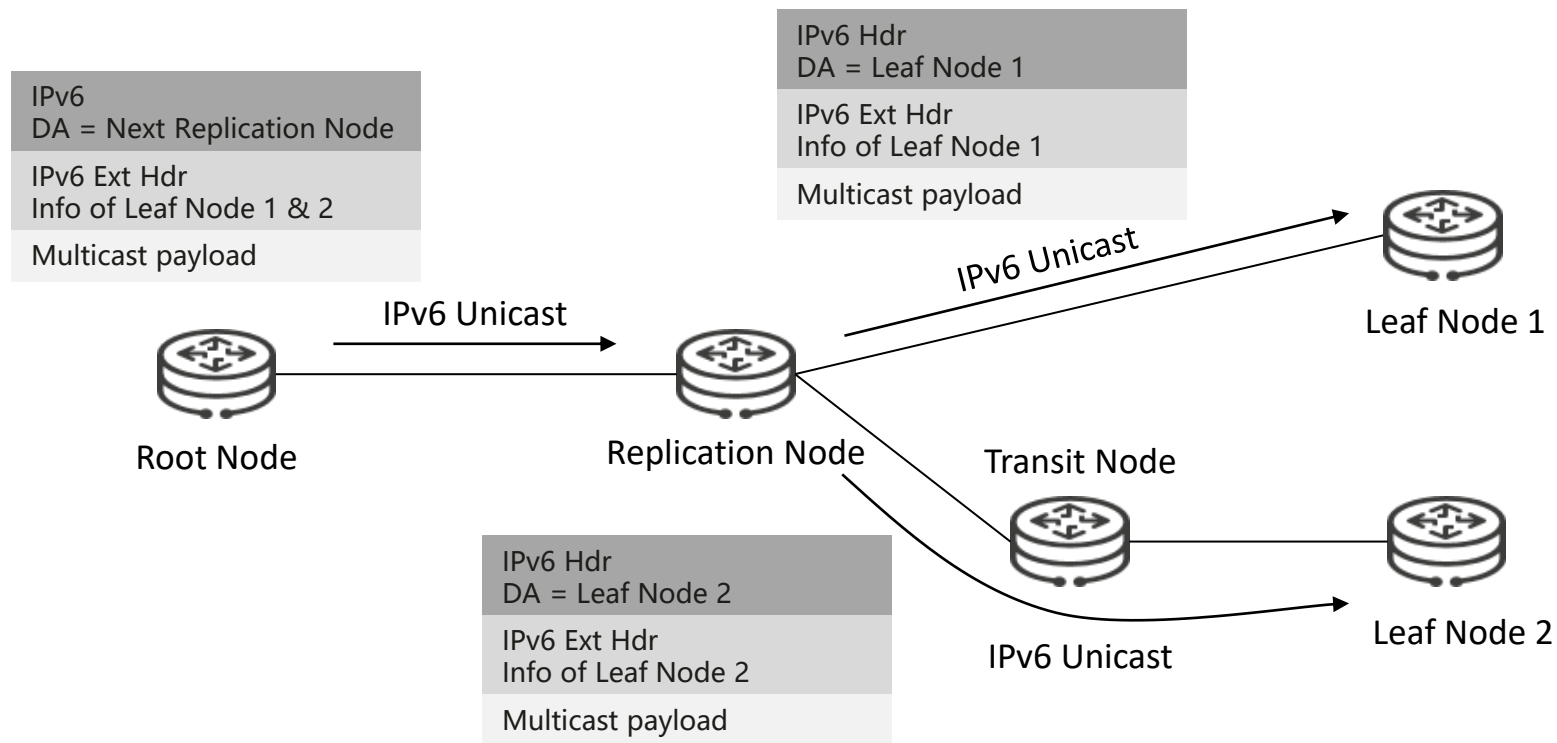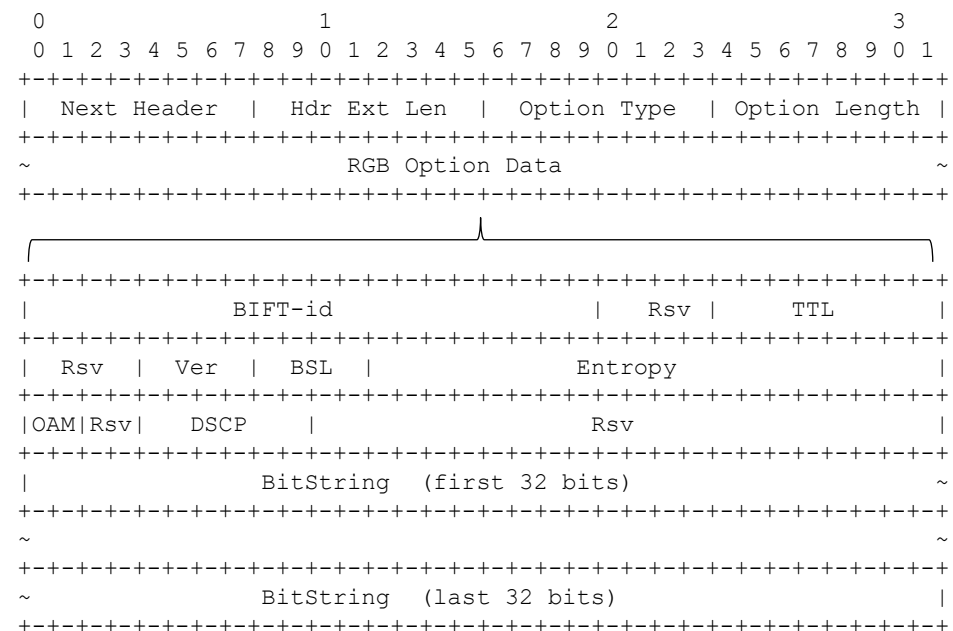
RGB Segment & RGB Option

- IPv6 Header with RGB Segment as Destination Address, indicating the next MSR6 Replication Endpoints in an MSR domain.

- IPv6 Destination Options Header with RGB Option, carrying global bitstring of egress nodes and reusing BIER mechanism.

```
+----------------+----------------+----------------------+
|  IPv6 header   |  IPv6 DO Header|  Client Multicast    |
|DA = RGB Segment|  with RGB Option| Packet or Upper      |
|                |                |  Layer Encapsulations|
|  Next Hdr = 60 |    Nxt Hdr = X |                      |
+----------------+----------------+----------------------+
|                |                |                      |
|<---------MSR6 BE header--------->|<--MSR6 BE payload--->|


End.RGB Behavior:

1. Lookup BIFT(Bit Index Forwarding Table, RFC8279) based
on the bitstring inside the RGB Option Data.
2. Forward the packet via the matched entry in the BIFT.
```
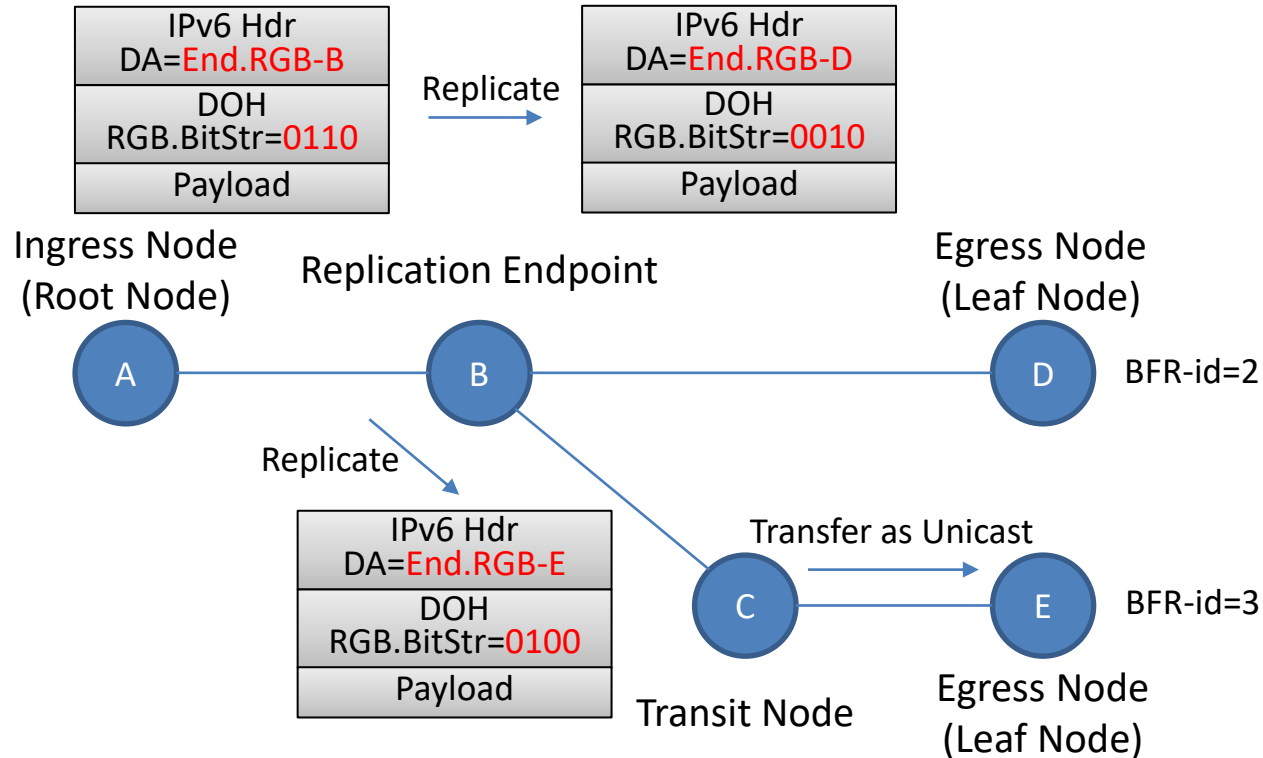
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Next Header  |  Hdr Ext Len  |  Option Type  | Option Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                         RGB Option Data                       ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+


+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 BIFT-id                  | Rsv |     TTL      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Rsv  | Ver  |  BSL  |                 Entropy                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|OAM|Rsv|   DSCP    |                  Rsv                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              BitString  (first 32 bits)                    ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                                                              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~              BitString  (last 32 bits)                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Packet Processing Procedure

| IPv6 Hdr |
| DA=End.RGB-B |
| DOH |
| RGB.BitStr=0110 |
| Payload |

Replicate →

| IPv6 Hdr |
| DA=End.RGB-D |
| DOH |
| RGB.BitStr=0010 |
| Payload |

Ingress Node
(Root Node)

Replication Endpoint

Egress Node
(Leaf Node)

A — B — D   BFR-id=2

Replicate

| IPv6 Hdr |
| DA=End.RGB-E |
| DOH |
| RGB.BitStr=0100 |
| Payload |

Transfer as Unicast

C → E   BFR-id=3

Transit Node

Egress Node
(Leaf Node)

- Ingress Node: A host originating the MSR6 packet, or a router encapsulating the customer packet in an MSR6 header.
- Replication Endpoint: Get an RGB Segment instruction by FIB lookup, and process the RGB Option in DOH. Look up the corresponding BITF, replicate the packet, update the bitstring and DA in each replicated, and forward to the next MSR6 Replication Endpoints.
- Transit Node: Transit the packet as a unicast IPv6 packet. Can be MSR6-unaware.
- Egress Node: If it is the edge of a network domain, send the packet to the multicast flow overlay; If it is the host supposed to receive the packet, send the packet to the upper layer.

Source Segment Concept

- ## SRv6-SID as Destination Address:

  – [RFC8402] The active segment is indicated by the Destination Address (DA) of the packet.

- ## SRv6-SID as Source Address in the existing work:

  – [RFC8986 & RFC9259] The active segment (SRv6-SID indicated by the DA) can be PING.

  – [RFC4433] Requires that the IPv6 address in the DA of a Ping request (the SRv6-SID above) as SOURCE Address of the Echo Reply Packet.

- ## draft-xl-msr6-source-segment:

  – Uses MSR6 SID as SOURCE Address of an IPv6-encapsulated multicast packet.

  – The MSR6 Segment represented by such MSR6 SID is defined as "Source Segment" .

Source Segment for MSR6 MVPN service

- In the multicast service, packet is replicated along the tree towards a set of leaf nodes. MVPN information could be encapsulated in the Source Segment carried in the IPv6 source address.

- Source Segment is distributed by the root node and the function is executed by the leaf nodes.

- Source Segment is not changed when the packet is replicated and forwarded along the P2MP path.

- Not only for MSR6 MVPN, Source Segment can also be used for MVPN based on other multicast technologies, e.g., BIER, PIM, SR-P2MP.

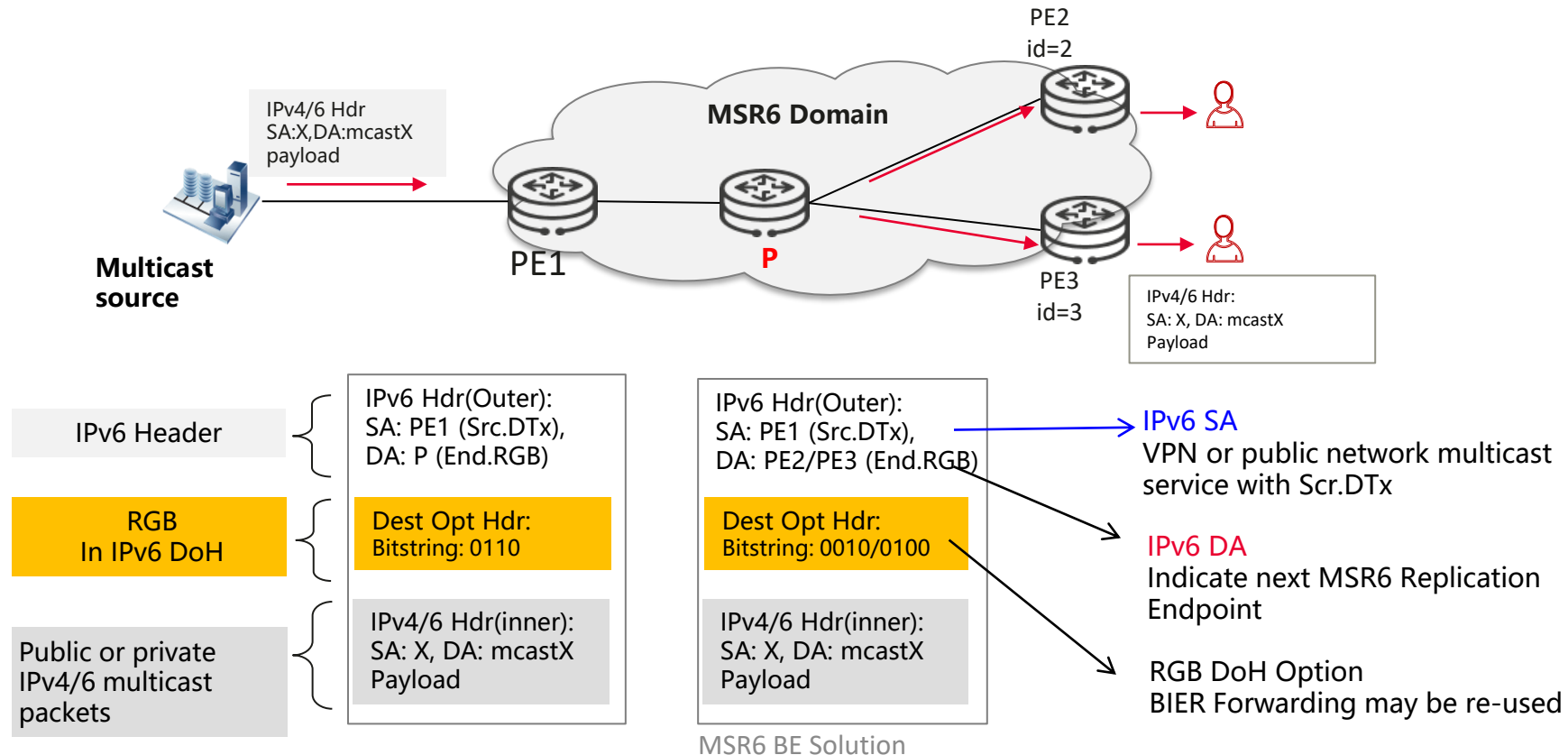Using source segment could bring the following benefits:

✓ Extend the programming space in IPv6 header.

✓ Provide semantic for source address.

✓ Facilitates security management inside the limited domain.

Source segment behaviors:

Src.DT4	Source address for decapsulation and IPv4 table lookup
Src.DT6	Source address for decapsulation and IPv6 table lookup
Src.DT46	Source address for decapsulation and IP table lookup
Src.DT2	Source address for decapsulation and L2 table lookup

Encapsulation of Source Segment and RGB Segment for MSR6 MVPN

- Use Source Segment in the IPv6 source address for identifying a VRF in IPv6 multicast source routing.
- Use RGB Segment in the IPv6 destination address for indicating the next Replication Endpoint.
- Use RGB Option in the DOH for carrying the global bitstring of egress nodes.

Multicast source

IPv4/6 Hdr
SA:X,DA:mcastX
payload

MSR6 Domain

PE1

P

PE2
id=2

PE3
id=3

IPv4/6 Hdr:
SA: X, DA: mcastX
Payload

IPv6 Header

IPv6 Hdr(Outer):
SA: PE1 (Src.DTx),
DA: P (End.RGB)

IPv6 Hdr(Outer):
SA: PE1 (Src.DTx),
DA: PE2/PE3 (End.RGB)

RGB
In IPv6 DoH

Dest Opt Hdr:
Bitstring: 0110

Dest Opt Hdr:
Bitstring: 0010/0100

Public or private
IPv4/6 multicast
packets

IPv4/6 Hdr(inner):
SA: X, DA: mcastX
Payload

IPv4/6 Hdr(inner):
SA: X, DA: mcastX
Payload

IPv6 SA
VPN or public network multicast service with Scr.DTx

IPv6 DA
Indicate next MSR6 Replication Endpoint

RGB DoH Option
BIER Forwarding may be re-used

Next Steps

- Revise the draft according to feedbacks

  - Comment by Toerless: removing unnecessary fields in the RGB Option.

  - Other MSR6 BE solution, e.g., draft-chen-pim-be-mrh: discussing with the authors for coordination between different solutions.

- Any questions or comments are Welcomed

Thanks